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The Crisis and the Foundry

Since the Parliamentary recess, the following events of major importance have occurred. The convertibility of sterling into dollars has been suspended. Timber imports have been limited. The agricultural industry is to receive higher prices for crops, it is to be supplied with more tools and to be aided by the provision of increased rural housing for its workers. Coal has increased in price by 4s. per ton at the mine, with a promise of a further advance in October, when railway rates are to be higher. All these factors will have a profound influence on the foundry industry. Consequent upon the dollar crisis, there is a specially urgent need to export. For much of its export business, the foundry acts as a secondary industry, supplying engine cylinders, base plates and general engineering components. For these lines it can make no direct contribution, but must rely on the sales organisations of its customers or of a separate department in the case where the foundry is attached to an engineering concern. The traditional exports of the foundry are cast-iron pipes, cooking and heating stoves, flushing cisterns, baths, propellers, dredger buckets, tramway crossings and points, and a few other items. There also used to be a limited market for rain water goods. It would appear from the trend of events that there is to be a slowing down in the building programme which would leave plenty of capacity for re-engaging in export by the makers of light iron castings. How serious this is to be is difficult to envisage.

Mr. Morrison, the Lord President of the Council, in answer to a questioner at a recent Press Conference, was understood to say that the Cabinet had under consideration the concentration of industry, but left a doubt in the minds of those present as to whether under peace conditions this could be implemented. Obviously, the very idea is disturbing, and will add to the already acute feeling of frustration which is shared by everybody in control of industry. One redeeming feature is that the suggestions for the general rehabilitation of the farming industry have met with general approbation. This programme will place a useful load on that section of the industry most likely to be affected by the reduction in general building and the reduction in the home demand for cars consequent on the petrol cut; a foundry capacity convertible into the production of tractors and the like.

Finally, there is the burden of extra fuel costs. We have used the word fuel, as it will not be long before the electricity and gas supply authorities will send out notices that " Owing to the increased price of coal, we regret . . . etc." The story is all too familiar. Naturally, too, the price of pig-iron, with scrap making a " sympathetic strike," will advance, as will that of coal dust, sands (owing to increased railway charges), and most other supplies and equipment. Thus there will follow an all-round increase in the prices of castings, and this matter will need the most careful attention. There must be no fixed percentage added to existing prices, an examination must be made so as to accord the buyer the lowest possible price commensurate with such a profit as will ensure the continuity of the business. This, of course, includes provision for modernisation and general development, but not for greatly enhanced trading profits, as these would help to extend the upward spiral of inflation.

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Olympia Exhibition

When the Exhibition opened, three firms whose names did not appear in the advance list of exhibitors were amongst those having stands in the "foundry" section. They were Wm. Cumming & Company, Limited, of Glasgow and elsewhere; F. and M. Supplies, Limited, of 4, Broad Street Place, London, E.C.2., and the Fullers' Earth Union, Limited, of Nutfield Road, Redhill, Surrey.

Wm. Cumming & Company, Limited, on Stand 20, Row H., show a wide range of foundry materials and the smaller type of plant, such as a sand mixer, 120-lb. crucible melting furnace, electric sand riddles, and a new type of small capacity sand drier.

F. & M. Supplies, Limited, are located on Stand a, Section 17, in the gallery of the Grand Hall.. They show ferro-alloy briquettes, core compounds, parting powder, and a few other lines of foundry supplies.

The Fullers' Earth Union, Limited, have Stand 13, Row D, and show Fulbond—a sand bonding material largely developed during the war, and now well established as a raw material of the industry.

CORRESPONDENCE

Westonite

A letter received from Mr. N. J. Dunbeck, managing director of Eastern Clay Products Inc., of Jackson, Ohio, tells us that his firm has the sole manufacturing rights for Westonite. He says that the actual moisture percentage is of the order of 2.5. This clears up an important point. The gases released, we are told, are highly reducing in character and occur in less volume than when coal dust is used. In a progress report written by Mr. Thomas W. Curry, metallurgist on the staff of the Lynchburg Foundry Company, the author has summarised the advantages accruing from the use of Westonite in the plant under his care, as follows:—(1) The time necessary to prepare the sand in the mullers has been reduced and more sand can be supplied to the moulding machines; (2) the chemically treated sand has better flowability characteristics than any synthetic sand used previously; (3) the toughness of the Westonite-treated sand can be increased to a specification which will mould on all of the current patterns without affecting its good flowability properties; (4) high strength, or high toughness, whichever is desired, can be developed in the Westonite-treated sands at much lower moisture contents; (5) by virtue of the use of a finer grain sand with good flowable properties and lower permeability requirements, it is possible to extend the use of a single sand over a wider range of castings; (6) lumping has been largely eliminated; (7) bond and cereal additions at the mullers have been reduced with the Westonite sand; (8) more accurate muller control has been made possible; (9) in general, there has been a reduction in cleaning time with the use of Westonite sand, some castings being affected more than others; (10) the men engaged at work on the mechanised unit are in hearty accord with the change to Westonite sand.

The Infra-Red Drying of Cores by Coal-gas

The Technical Department of the British Gas Council inform us that cores can be dried by radiant heat in time varying from 14 min. for thicknesses $\frac{1}{16}$ to $\frac{1}{16}$ in., rising to 18 min. for $\frac{1}{4}$ in. and to 25 min. for cores up to 2 in. in dia. Detailed tests have been made in the foundry of The Parkinson Stove Company, Limited, in

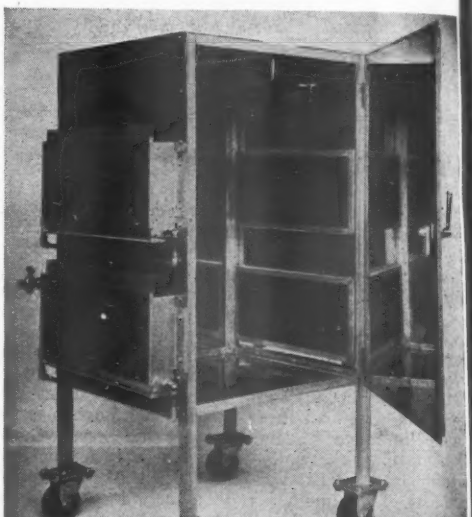

FIG. 1.—OVEN USED FOR EXPERIMENTAL DRYING OF CORES.

conjunction with the Birmingham Gas Department. Core drying is successfully accomplished by means of infra-red, the difficulty is not so much connected with the application of radiant heat, but with the devising of a suitable means of transport of the core boxes. Fig. 1 shows the type of tunnel used for experimental core drying. An installation complete with conveyor is being used for the drying of foundry blacking on completed cores, the time taken for the process being approximately 5 min. Cores dried in this installation vary considerably in size but all are satisfactorily treated.

THE INSTITUTE OF BRITISH PHOTOGRAPHERS have organised an Exhibition which is to open at the Alpine Gallery, 74, South Audley Street, London, on September 5, and remain open until September 30.

DISCUSSION ON

Some Notes on Feeding

By S. L. Finch

DISCUSSION

MR. S. L. FINCH, to promote discussion, gave a *résumé* of his Paper on practical and theoretical aspects of the feeding of steel castings before the annual conference of the Institute of British Foundrymen at Nottingham on June 18 (*see* FOUNDRY TRADE JOURNAL, *July* 31 *and August* 7, 1947).

The Heuver Method

MR. H. J. YOUNG, opening the discussion, said that the ironfoundry under his control dealt with something like 100,000 patterns at the rate of, say, 300 every week. He felt, therefore, that if they adopted the Heuver method of describing circles where two or more walls of a difficult casting met, they would be very busy drawing circles. Few people would see any need to draw a circle where perfectly obviously there occurred a greater thickness; as had been done in Figs. 1, 2, 3 and 4 of the Paper (see JOURNAL, July 31, page 297). A method of this kind was one he would put to a practical test, such as the following. Large couplings were always tricky castings to obtain perfect, not only when machined all over, but also through the boss (which may be machined out to any size to suit some particular shaft). Here, in the boss, was where a draw-hole might occur. One large coupling, however, came to the foundry in three different forms, namely:—(*a*) As a plain solid casting; (*b*) similar, but having four cored holes of 1½ in. dia. around the boss; and (*c*) again the same, but with eight of the cored holes. Of these three varieties of the same casting, one was *immeasurably* more difficult to produce perfect in the bore than either of the other two. The coupling was illustrated in Fig. A. If the Heuver circling method was any use it would surely pick out the "rogue" design of these three couplings; if, however, the Heuver circle merely enclosed what was obvious, it appeared to him to be a little redundant.

Assuming one was working in grey cast iron, Figs. 4 and 5 did not appear reasonable. Moreover, it was clear that a Heuver circle of exactly the same diameter as that in Fig. 4 could be inserted in Fig. 5 and precisely the same deductions drawn therefrom. He (the speaker) suggested that this circling business led nowhere. Omitting the more practical portions, which probably apply to steel, the Paper contained much of deep interest, although the Author adopted nomenclature and formulæ which an ordinary individual like the speaker was unable to understand and, therefore, to accept. An example of this occurred at the end of the third paragraph, where the Author said: "The rate of feed demand on head efficiency is outlined." Why "rate"; why not "amount"? In plain language, did not the Author mean that if one put a feeder-head on a casting, it must be able to supply sufficient metal if it were to effect its purpose? Personally, the speaker could not see why it should matter whether that "amount" of metal were supplied in one minute or ten, so long as it *is* supplied. The late Mr. Ronceray had gone pretty deeply into this matter. These criticisms, however, were by no means intended to be derogatory of anything save certain details.

MR. GRAY recalled what he described as a rather painful experience with flywheels in steel, and wished to suggest that the circle in the diagram was not drawn in the right place. One had to have regard to the head of the casting as well as the flywheel itself, and if the head were examined, the other big section was at the point where the head joined the rim. It was there they had the trouble with flywheels. He was interested to find that in Germany there were two factories, the largest of which was making 30-ton and 40-ton flywheels, where they used a similar method to the one referred to in the Paper, but at both those factories there was indication of unsoundness in the head, showing that that was where the real trouble came, whereas the section in the Paper showed that the real trouble was radially, round the rim, and he thought that really the position of the circle should be raised.

MR. FINCH agreed, but said that could only be overcome by a modification of the shape of the head, which would raise the circle. It was true that coming down to a very close study of the circle it was in the wrong place in comparison with the heads that had been drawn, but it could be lifted by altering the shape of the feed head and the type of padding.

Exothermic Feeding Heads

MR. J. G. BAILES, referring to Fig. 10, Point B, which used exothermic material to assist feeding, asked: "Did Mr. Finch not think that by using that material at those points one would get micro-shrinkage at the bottom corners in any fillet, and more particularly in a sharp angle? He (the speaker) had found that in using this method micro-shrinkage was very prevalent. Had Mr. Finch overcome that difficulty?"

MR. FINCH replied that Mr. Bailes had been fortunate if he had been able to get the exothermic material. The practice was an American one, and, although his (Mr. Finch's) firm had endeavoured to get some of the material, they had not been able to

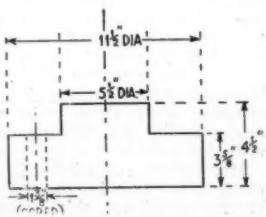

FIG. A.—COUPLING CASTING.

Discussion on Feeding

obtain a supply. This section of the Paper was theoretical, but at the same time he could say that many castings had been produced in the States by the use of exothermic mould material. Several Papers had been written about it, and he had been kept informed of the latest details by his friends in the States, and, so far as he knew, they had had no trouble with micro-shrinkage. Whether the method was as good as claimed he was not prepared to say.

MR. F. A. MARTIN, saying that he would have liked to ask one or two questions about the exothermic material, was sorry that Mr. Finch had not got first-hand experience of it. He expressed the view that an exothermic material, unless it was something entirely new, must be dependent upon the oxidation-reduction reaction. The material which was reduced was contained within the refractory material, and he would be glad to know what the mass of refractory material was like when the reaction was through. If that material were sand, if that sand were mixed with the reacting materials and had also got the metal mixed closely with it, it was not only going to be a very difficult job to get it off the casting, but anything that fell off was going to make a horrible mess of the sand in the system. He would like to know what the exothermic material was like after the reaction was over.

MR. FINCH said he was sorry he could not give any details as to the composition of the exothermic material, but he had a good second-hand knowledge, showing that it had good stripping properties and that its exothermic reaction could be controlled, in theory, from a few minutes to a few hours, although he did not know how that control was effected and could not at the present time find out. It was a patent material which was sold on the market in the States, and, as he had already said, they had tried to get some of it, but had not been successful. He was afraid he could not give any more information.

MR. V. C. FAULKNER pointed out that in referring to the exothermic material, Mr. Finch had used the word "patent," and asked if it would not be more correct to state that it was a proprietary material. MR. FINCH agreed.

MR. J. H. COOPER said that, as the manufacturer of an exothermic material, he could assert that the effect of his material after its use in the head of a casting was not detrimental. In feeding any type of casting, the feeding material should be placed on, as soon as the metal entered the head and rise up with it. In that way one got perfect feeding.

The CHAIRMAN (Mr. N. P. Newman) asked whether it was clear that the material to which Mr. Cooper was referring was not that which was put into the head to retain fluidity, but was material actually incorporated with the mould.

MR. COOPER replied that it could be used in any way whatever. For instance, if there were difficulty in keeping metal hot, this material could be put on the ladle metal. He added that he could give the formula if necessary.

MR. FINCH replied that he hoped Mr. Cooper would not think he was being critical, but the material to which he (Mr. Finch) referred was an entirely new material, developed in the States, and was mixed with sand. It was some form of refractory and exothermic material and could be used inside the head, but it was used chiefly, as he had tried to illustrate by a simple diagram, to permit of directional solidification and also to generate heat slowly or rapidly, as the case might be, around the feeder head.

Modes of Feeding

MR. NICHOLLS said he noticed that in Figs. 1 and 2, Mr. Finch illustrated various methods of feeding and a combination of top feeder and side feeder, and asked if Mr. Finch could say what method of feeding had been found to give the soundest results, all things being equal—side feeding, direct top feeding, or a combination of top and side feeding.

MR. FINCH said he could not answer that question because it all depended on the type of casting and on the material available as to what combination of feeding methods should be or might have to be used, but one point which should be borne in mind was that a balanced system of feeding must always be used. If that rule were obeyed, irrespective of whether side heads or top heads were being used, and providing all other factors were under control, one would get a sound casting. He modified that statement by saying one *should* get a sound casting, because everyone knew there were factors which were so variable that they could not be controlled.

Wall Friction

MR. C. H. KAIN, alluding to the conclusions set out on page 10 of the preprint of the Paper, asked Mr. Finch if he would develop the point with reference to wall friction as affecting the feeding of castings. For many years, he (the speaker) held the view that the friction of the metal against the mould had a very pronounced effect on the feeding, and particularly on hot-tears. A few years ago, Prof. Andrew carried out some research on that matter and decided that mould friction, as distinct from wall friction, did not have any marked effect on the incidence of hot tearing. Was Mr. Finch referring to wall friction between the solid metal and the mould, or the wall friction between the liquid metal and the solid metal on the outside of the wall which would occur earlier?

Secondly, he desired to ask Mr. Finch if he had any experience of preheated moulds—of heating the moulds completely and entirely, then allowing the whole mould and the casting in it to cool down under what were presumably theoretically ideal conditions. Mr. Kain, continuing, said that, some years before the war, he was in Switzerland and saw this method developed to a great extent on light castings, with quite remarkable results, and it seemed to him it would be much easier to preheat the whole mould and allow freezing to proceed slowly through the whole mould and the casting, rather than to worry about preheating or exothermic reactions in sections of the mould.

MR. FINCH, in reply, drew attention to No. 3 of his conclusions, "The flow of metal from a feeder head to the solidifying casting is a complex problem governed by factors such as fluidity, wall friction and head pressure," and said that the wall friction there referred to was the friction that occurred between the ingrowing crystals and the liquid interior. The effect of that crystal growth on the flow of liquid that took place earlier must be considerable. He had drawn attention to that earlier in the paper; perhaps it had not been too clear, but he had made reference to a moving stream and the effect of ingrowing weeds. It was a simple illustration, and he thought it applied in a certain degree to metal inside a feeder, and the ingrowing crystals.

The effect of heating a mould was always dependent on the amount of heating that took place and the effect that had on the rate of cooling. He had heated moulds wholly, including round the feeder head, and as far as he could ascertain there had not been any increased efficiency in the feeding. There seemed to be no improvement in feeding efficiency by heating the mould, and although heating round the head was theoretically correct, it seemed to have very little practical advantage in steel. He was limiting his latter remarks to steel.

MR. KAIN said he gathered that the question of mould friction between the liquid and the solid metal was just a theoretical consideration and that there were no data available?

MR. FINCH replied that Schwartz had done some work in this connection, and although he did not give any definite data he had made a good contribution to the subject and had discussed the effect of such friction, which must be considerable.

Hot Moulds

MR. C. GRESTY welcomed the opportunity of commenting on Mr. Kain's remarks regarding the use of hot moulds in view of his experience with the Lanz Perlit iron process. He thought there was no doubt that it was correct to say that the heated mould could be called a half-way house between an unheated mould and one made partly of exothermic material. He did not think Mr. Finch appreciated just what could and did happen in a hot mould. There was not only the mere fact that the mould was hot, but where the hot mould was on both sides of a thin section of metal, its effect was very much greater than in other parts of the mould where the section of metal was heavier. Therefore, one did get much more even cooling, and it followed that one also got much more efficient feeding. He would like to have Mr. Finch's remarks on that aspect of the matter.

MR. FINCH said it was quite true that in a thin section there might be a considerable improvement because of the different formation of crystal growth. In reply to a question as to what was meant by a "hot" mould in terms of degrees, Mr. GRESTY said that in practice it worked out at between 400 and 600 deg. C., according to the thickness of the casting. In light section work, they went up to about 600 deg. C. —anything above that was liable to lead to sand troubles. MR. FINCH said he was referring in his answer to a mould of about 150 deg. C., which was a considerable difference, and also he was referring to steel.

Sawdust-Sand Mixtures

MR. A. TIPPER desired to focus attention on the importance of rate of solidification, and said he thought the Paper warranted study from that angle. He was interested, as a member of Technical Council Sub-Committee TS21, in the effect of various moulding materials on the rate of solidification and in that connection, the use of insulating materials as special moulding materials was going to play a very important part, and the more facts they could establish the greater would be the benefit to the industry.

Heat Insulation

He had experience, on light alloys in particular, with some of the special plasters and similar materials which had remarkably good insulating properties, not only because of their nature, but because of the closeness and lack of permeability of the mould produced. They gave an extremely slow freezing rate and could, he believed, be used with great advantage in certain moulds where a large feeding head formed a separate part of the mould. He would like to know if Mr. Finch had had any experience of the special mixtures and of the effect they had in reducing the size of head in particular castings?

MR. FINCH replied that the only insulator he had used on steel castings had been a mixture of sawdust and sand, and one could not estimate quantitatively the effect that it had on the feeder head, but it did improve feeding efficiency by keeping the head at a higher degree of fluidity than it would normally have, and it retained that fluidity for a longer period than when ordinary sand was used. Work had been done on quite a large scale on sawdust additions to sand, and it was possible to make a slight reduction in feeder head capacity, but he did not think any quantitative measure had been established.

Feeding Head Practice

MR. MERCER, referring to Fig. 3, asked Mr. Finch why there were two heads?

MR. FINCH said very good results had been achieved on this type of casting. He had, for instance, been successful in producing gear blanks of 5 ft. in dia. with one head, and yet at another foundry where the steel showed a marked difference in fluidity at the same temperature, with the same process it was difficult to get a sound blank with four heads. They had tried one, two, three and four heads but had not been successful and had had to revert to the old method shown in Fig. 1, but that was one of the variables that did occur. He did not know what was the fluidity of the steel which Mr. Mercer used, but it was a most important factor. The yields between foundries varied. At one foundry with which he had been associated the average yield was 64 per cent., whereas at the one with which he was at present associated, that would

Discussion on Feeding

not be possible because of the difference in the fluidity of the steel. That was the only cause to which one could attribute the difference in yield. Castings of 5 ft. dia. could be produced by the first foundry with one feeder head; in the second foundry, five or six top heads were necessary. It was a most interesting feature, to which he intended to give further study because he did not know the full answer, but he felt that if a close study was made this variable would be found to be general throughout the foundries.

MR. MERCER said he attributed the trouble to the carelessness of the people who were casting. When he was casting by the American method, he had found on X-ray examination that if one went to the other end and drove the hot steel back one attained solidity. It was a matter of giving the greatest attention while casting. One could get 100 per cent. efficiency by the exercise of care.

Fluidity

MR. F. COUSANS said he was glad the subject of fluidity had been raised, because he thought the need for adequate fluidity in steel had perhaps not been sufficiently stressed in the Paper. He could confirm that hot fluid steel fed very much better than steel of the same temperature but not possessing the same fluidity. In that connection, he asked whether Mr. Finch had any experimental data at the back of his mind in preparing Fig. 6, in which he showed the general relationship between temperature and fluidity? Mr. Cousans said his experience to date with one particular plant was that there was very nearly a straight line relationship between the two, but that was not supported by Fig. 6.

He thought Mr. Finch had been wise in drawing attention to Heuver's method of circling to show the areas which it was essential to feed to obtain solidity, but at the same time he thought that method was open to a little misunderstanding. After all, they were dealing with a geometric shape. It was more of a sphere or an ovoid, and not merely a circle, and if that was realised probably their approach to the problem would be more successful.

He was pleased, too, with Mr. Finch's reference to insulating materials, and was sure they could tremendously improve their steel castings by adopting that method of insulation. With a 10 per cent. addition of sawdust to ordinary moulding sand they could get a thermal conductivity almost equal to that of a good insulating brick, and therefore the material had very definite possibilities. He remembered the case of a 0.40 to 0.45 per cent. C. steel anvil block weighing about 50 cwts., where a sleeve of insulating material was put round the feeding head, and that head was still liquid three hours later, which demonstrated the insulating properties of the material. The feeding head was also covered with Lapix powder

MR. FINCH said that while he was glad that the question of fluidity had been raised, at the same time he desired to point out again that, in his Paper, he did refer to those curves as showing trends and not actual evidence by experiments. Several different types of curves and straight lines had been given, which again was because the fluidity for a given temperature varied according to other factors which at the moment were uncontrollable. Each foundry might well find that, for a given temperature, their fluidity was different from that of another because of those uncontrollable factors. The question of fluidity was most important and should not be neglected in efficient feeding. He added that the Heuver method of circling was only intended as a guide and should not be used as a yardstick in making castings.

At the conclusion of the discussion, the CHAIRMAN said Mr. Finch's paper had resulted in a very interesting and practical discussion, and it was the type of Paper the Institute wished to encourage. He proposed a very hearty vote of thanks to the author, which was duly seconded and carried with acclamation.

Foundry Statistics

According to the Bulletin of the British Iron and Steel Federation, for the first time since the war, the labour force of the ironfoundry industry shows a decline. Figures relate to the week ending May 10, and at this time there were 135,690 people employed, of which 126,688 were males. These figures represent a loss of 310 males and a gain of 30 females, when compared with the week end of April 5. On a yearly basis, however, there has been a total gain of 19,667, made up of loss of 1,198 women and an increase in the male force of 20,865.

Steel for Steel Castings.—In June, the average weekly output was of the order of 7,500 tons, as against 6,900 tons in May and 6,100 tons in June, 1946. The weekly deliveries averaged 3,800 tons in both May and June as compared with 3,600 in June last year.

American Foundries

According to the 1947-48 edition of Penton's Foundry List, the total number of foundries in the U.S.A. and Canada has increased by 424 to give a total of 5,993. Canada has contributed 20 towards this gain, to give a total of 541 in the Dominion.

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Graphite Formation in Grey Cast Iron*

By H. Morrogh and W. J. Williams

(British Cast Iron Research Association)

(*Concluded from page* 396.)

Experiments with Nickel-Carbon Alloys

It is important to recall that, when considering undercooling as exemplified by the system betol-salol, it was tacitly assumed that the binary complex solidifying at the hypertectic point on the supersolubility curve consisted of a mixture of the compounds betol and salol and that these formed directly from the liquid without the intermediate formation of a metastable compound. Now the work of Eash showed that undercooling in cast irons occurs by a different mechanism and that undercooled graphite does not form directly on solidification from supersaturated liquid. The present investigators were impressed by this point and the question arose as to whether the type of undercooling found in iron-carbon-silicon alloys was unique or whether a similar process occurred in other alloys. It was therefore decided to investigate two other series of alloys to throw light on this subject.

When we have two metallic elements A and B and a third C, there is frequently considerable analogy in the binary systems A-B and A-C when the elements B and C come from the same group in the periodic table or come from the same period of transitional elements. To compare with iron-carbon or iron-carbon-silicon alloys we have two extremely useful systems in nickel-carbon and cobalt-carbon alloys. The elements iron, cobalt and nickel are neighbours in the first long period and in this period they are the last three transitional elements. The atomic numbers are 26, 27 and 28 and their atomic weights are 55.85, 58.94 and 58.69 respectively. These three elements all give alloys with carbon depicted in equilibrium diagrams of great similarity. The systems are all eutectiferous, involving a eutectic of graphite and a solid solution of carbon in the metal. The crystal structures of the solid solution is probably the same in each case—face-centred cubic with interstitial carbon. The liquidus on the metal-rich side of this eutectic indicates the primary deposition of this solid solution from the melt and on the carbon-rich side it indicates the deposition of graphite from the melt. In all three systems the solubility of carbon in the solid solution decreases with decreasing temperature.

The equilibrium diagram taken from Marsh[29] for nickel-carbon alloys is given in Fig. 12 and includes all the reliable data. The cobalt-carbon system[30 31 32] is essentially similar to the nickel-carbon system. Investigators studying these systems produced no valid evidence of the existence of either Ni_3C or Co_3C, although both of these compounds have been prepared by passing carbon monoxide over the heated metal powders. In the course of the work by the present investigators, both carbides were found to exist as metastable phases in rapidly cooled alloys, indicating a marked similarity to iron carbide. Cobalt carbide appeared to be less stable than iron carbide and nickel carbide less stable than cobalt carbide. The crystal structure of cobalt carbide[33] has been found to be very similar to that of iron carbide[34], but nickel carbide has surprisingly been reported[35] as having a close-packed hexagonal structure.

The present investigators have studied graphite formation and undercooling in nickel-carbon and cobalt-carbon alloys, but only the general results of the experiments will be presented here. For full details and an account of the experiments on the nickel-carbon and the cobalt-carbon alloys reference should be made elsewhere to more detailed account[1] (*loc. cit.*).

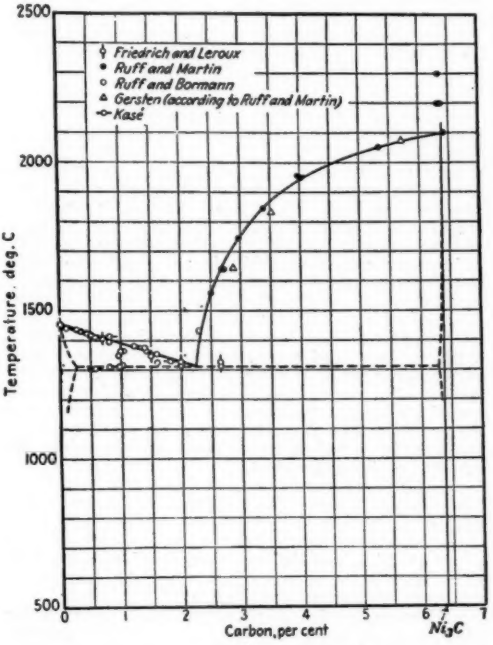

FIG. 12.—THE EQUILIBRIUM DIAGRAM FOR THE NICKEL-CARBON SYSTEM (MARSH).

* Paper presented at the Nottingham Conference of the Institut of British Foundrymen.

Graphite Formation

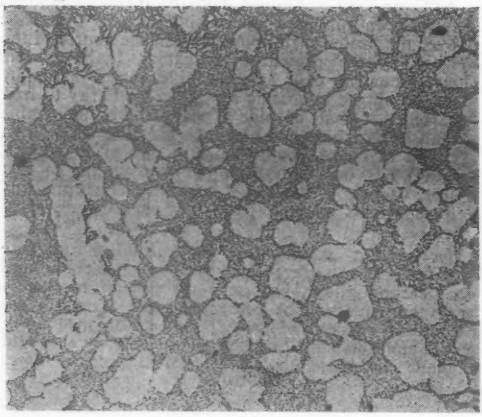

FIG. 13.—UNDERCOOLED GRAPHITE IN A HYPO-EUTECTIC NICKEL-CARBON ALLOY. UNETCHED × 60.

Results of Experiments on Nickel-Carbon Alloys. Both hypo- and hyper-eutectic nickel carbon alloys were studied* and it was found that, in the absence of other elements, the hypo-eutectic alloys gave structures resembling those of undercooled graphite in hypo-eutectic cast irons. A typical example is shown in Fig. 13. In hyper-eutectic alloys long straight flakes of hyper-eutectic or "kish" graphite were obtained, together with eutectic graphite in an undercooled form. When hyper-eutectic nickel-carbon alloys were melted in graphite crucibles and allowed to cool slowly, the hyper-eutectic graphite tended to float out, giving structures similar to those shown for cast irons in Figs. 7, 8 and 9. A typical example of the fragmented hyper-eutectic graphite at the top of such an ingot is shown in Fig. 14, whilst Fig. 15 shows the fine eutectic graphite in the central zones of the ingot from which the graphite had floated. Obviously, hyper-eutectic graphite in nickel-carbon alloys can inoculate the eutectic to give flake graphite.

The addition of sulphur to nickel-carbon alloys was found to give normal flake graphite structures exactly similar to those obtained in cast irons. In the absence of manganese, sulphur exists in nickel-carbon alloys as Ni_3S_2 and in the presence of manganese as MnS. It was found that sulphur gave the coarse flake structures regardless of its mode of occurrence. A typical example of a sulphur-containing nickel-carbon alloy is shown in Fig. 16. In this context it is interesting to recall the findings of Boyles, mentioned earlier, that cast irons and iron-carbon-silicon alloys tended to give undercooled graphite structures unless sulphur was present.

Examined at high magnifications under polarised light, the graphite flakes in nickel-carbon alloys had the same optical properties and orientations as described earlier for graphite flakes in cast irons. Furthermore, at high magnifications under polarised light the same complex internal structures were found in the graphite flakes.

Various inoculation experiments were tried on nickel-carbon alloys and a remarkable result was achieved when calcium silicide was used for this purpose. This addition was found to cause the graphite to occur in perfectly-formed spherulites, particularly when the alloy was slowly cooled. The same result was obtained whether the alloy was hypo- or hyper-eutectic in composition. Fig. 17 shows the spherulites of graphite obtained by treating a nickel-carbon ingot melted in a graphite crucible. This micrograph was taken in the central portion of the ingot from which the hyper-eutectic graphite had floated to the top. The hyper-eutectic graphite was also produced in a spherulitic form and the spherulites tended to float to the top of such ingots. A typical example of a segregation of spherulitic hyper-eutectic graphite at the top of an ingot is shown in Fig. 18. At high magnifications these spherulites produced by calcium silicide additions were found to have a structure identical with that found in spherulites in malleable cast iron and to have the same crystallite orientation as described previously. At the time this discovery appeared to indicate a unique feature of nickel-carbon alloys.

It was subsequently found that the production of graphite spherulites was not a special feature of calcium

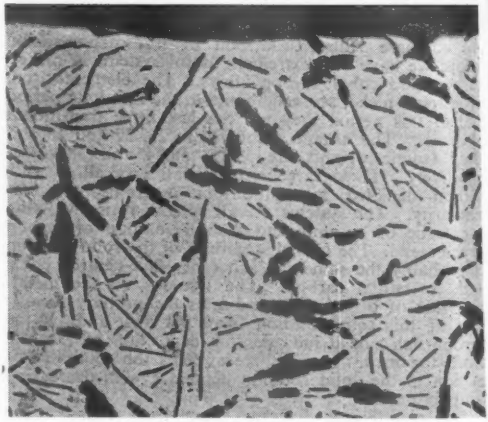

FIG. 14.—A SEGREGATION OF FRAGMENTED HYPER-EUTECTIC GRAPHITE AT THE TOP OF A NICKEL-CARBON INGOT MELTED IN A GRAPHITE CRUCIBLE. × 60.

*In all cases these alloys were made by dissolving electrode carbon in pure nickel.

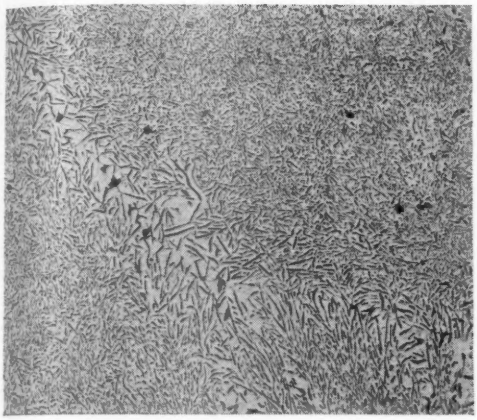

FIG. 15.—FINE EUTECTIC GRAPHITE IN THE CENTRAL ZONE OF A HYPER-EUTECTIC NICKEL-CARBON INGOT MELTED IN A GRAPHITE CRUCIBLE. THE HYPER-EUTECTIC GRAPHITE HAS FLOATED TO THE TOP OF THE INGOT. UNETCHED. × 60.

silicide alone, but that any alloy or compound, the use of which would give calcium alloyed with the nickel-carbon alloy, would also give spherulitic graphite. Furthermore, it was found that the elements barium, strontium and magnesium had an effect similar to that of calcium.

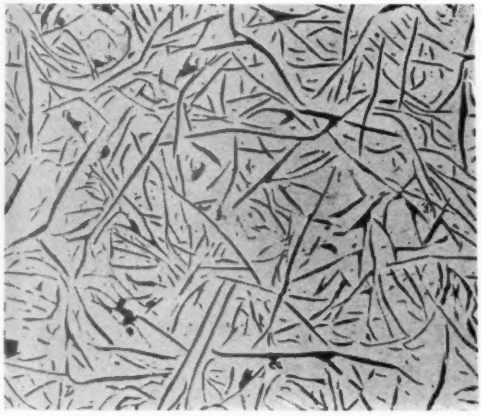

FIG. 16.—COARSE FLAKE GRAPHITE IN A SULPHUR-CONTAINING NICKEL-CARBON ALLOY. UNETCHED. × 60.

The production of spherulites in nickel-carbon alloys was not obtained when a prior addition of sulphur was made. In this respect sulphur had the same effect whether present as Ni_2Si_2 or as MnS. The fundamental reason for this has not yet been elucidated. Rapid cooling from the liquid state, air-cooling or water quenching, also gave nodular structures. A typical example of an air-cooled ingot (weighing about 60 gm.) is shown in Fig. 19. The spherulites produced by rapid cooling were not perfect in outline, but the typical radial spherulitic structure was always present, as is seen at high magnification in Fig. 20. The presence of sulphur also prevented the formation of spherulites by rapid cooling.

Cooling curve studies were made on nickel-carbon alloys and it was found that the eutectic temperature was the same for alloys giving the undercooled struc-

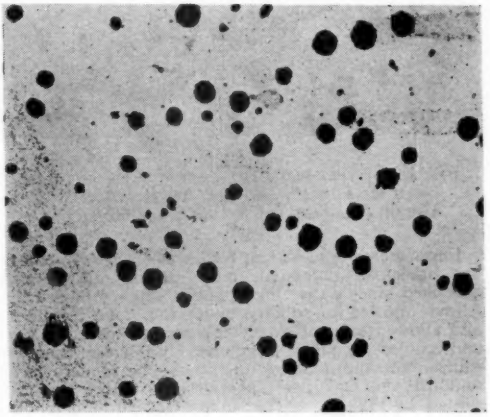

FIG. 17.—SPHERULITIC GRAPHITE IN A HYPER-EUTECTIC NICKEL-CARBON INGOT MELTED IN A GRAPHITE CRUCIBLE, TREATED WITH CALCIUM SILICIDE AND SLOWLY COOLED. TAKEN AT CENTRAL PORTION OF INGOT. UNETCHED. × 60.

tures as for the alloys giving spherulitic structures by calcium silicide additions. This temperature was 1,325 deg. C. ±1. Originally, some difficulty was experienced in producing coarse flake graphite structures without an addition of sulphur, but when a suitable inoculation technique was developed which did not cause an addition of sulphur, the eutectic arrest was found to be at least 10 deg. C. higher for flake graphite structures. Sulphur probably lowers the freezing point of the eutectic in nickel-carbon alloys. Obviously, undercooling is possible in nickel-carbon melts and the formation of graphite spherulites is related to undercooling. This latter point is indicated by the eutectic arrest temperature and by the effect of rapid cooling in producing spherulitic structures.

D

Graphite Formation

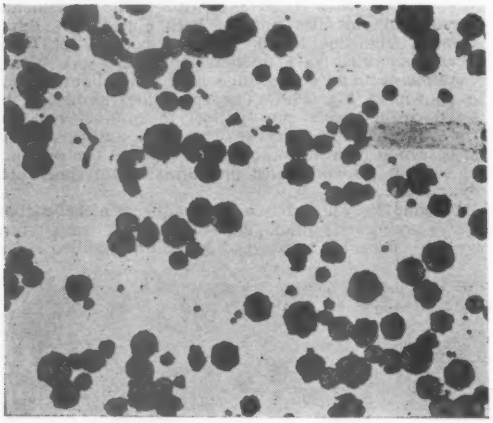

FIG. 18.—HYPER-EUTECTIC SPHERULITES IN SAME INGOT AS FIG. 17, SHOWING SEGREGATION AT THE TOP OF THE INGOT. UNETCHED. × 60.

Experiments were carried out in which slowly cooled, but otherwise untreated, nickel-carbon alloys were quenched into water immediately after solidification. Alloys allowed to solidify under the same conditions and allowed to cool slowly to room temperature gave undercooled graphite structures, but those cases in which the alloys were quenched immediately after solidification had fine spherulitic structure as illustrated in Fig. 21. This indicated that undercooled graphite structures in nickel-carbon alloys are produced by the solidification of a metastable eutectic which subsequently decomposes after solidification. It has since been possible to demonstrate that this eutectic consists of the solid solution and nickel carbide, which, being very unstable, decomposes even on rapid quenching to give nodular structures. It has also been possible to show that the function of calcium, magnesium, strontium and barium in producing nodular structures is to permit undercooling and the solidification of the nickel carbide, the decomposition of which is retarded and so gives spherulitic structures instead of the typical undercooled structures. Rapid cooling has a similar effect in preventing the decomposition of the nickel carbide until a lower temperature is reached.

The influence of calcium silicide additions upon the graphite structure in nickel-iron-carbon alloys was also investigated, and it was found that this addition caused the formation of graphite spherulites in all alloys with less than about 49 per cent. iron. With higher iron contents than this, calcium silicide additions had the normal effect of producing flake graphite structures.

In all the respects outlined above, cobalt-carbon alloys tended to behave very similarly to the nickel-carbon alloys, but evidence was obtained of the greater stability of cobalt carbide compared with that of nickel-carbide. Eutectic cobalt carbide was obtained by rapid quenching from the liquid, whereas nickel carbide was only obtained in a fine Widmannstätten pattern by the same treatment. Additions of calcium to cobalt-carbon alloys did not give nodular structures, but magnesium was always effective in this respect. These points clearly indicate the properties of cobalt-carbon alloys to lie midway between those of iron-carbon and nickel-carbon alloys.

Occurrence of Nodular Spherulitic Graphite in As-cast Cast Irons

In view of the marked general similarity of nickel-carbon and cobalt-carbon alloys on the one hand, and the iron-carbon-silicon alloys on the other, and in view of the production of spherulitic graphite in the former, it was argued that there was a high degree of probability that spherulitic structures could be similarly produced in iron-carbon-silicon alloys or cast irons. To determine whether this was so, a search was made, and it was discovered that nodular or spherulitic graphite could be produced in cast irons in isolated cases in small areas of the microstructure when conditions of composition, prior treatment, and cooling rate lent themselves to extensive undercooling.

It was found that hyper-eutectic graphite was obtained in this form more readily than eutectic graphite. A typical example of spherulitic hyper-eutectic graphite is shown in Fig. 22. The iron from which this micrograph was taken had the following composition:—T.C, 3.91; Si, 2.83; Mn, 0.62; S, 0.021, and Ph, 0.10 per cent.

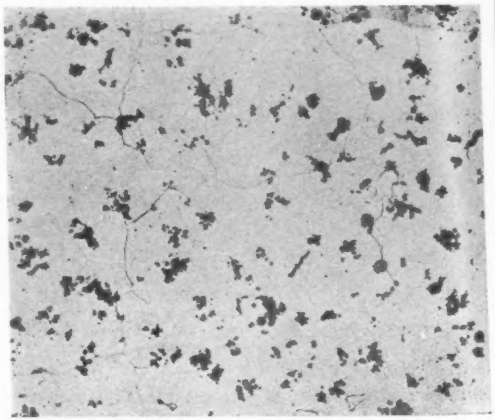

FIG. 19.—NODULAR STRUCTURE IN A NICKEL-CARBON ALLOY AIR-COOLED FROM THE LIQUID. UNETCHED. × 60.

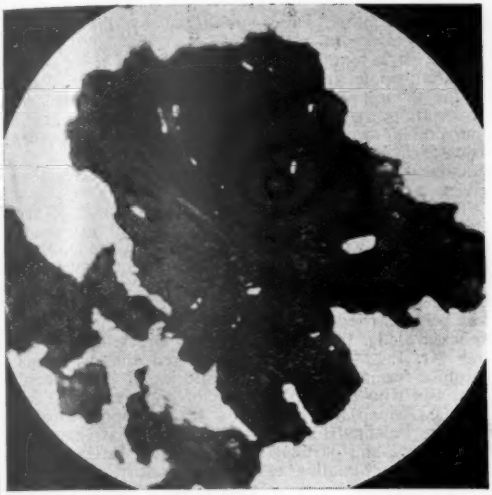

FIG. 20.—STRUCTURE OF NODULES IN AIR-COOLED INGOT SHOWN IN FIG. 19. UNETCHED. × 150.

If a careful study of Fig. 9 is made it will be seen that some nodules of hyper-eutectic graphite are present again in a hyper-eutectic sample in which

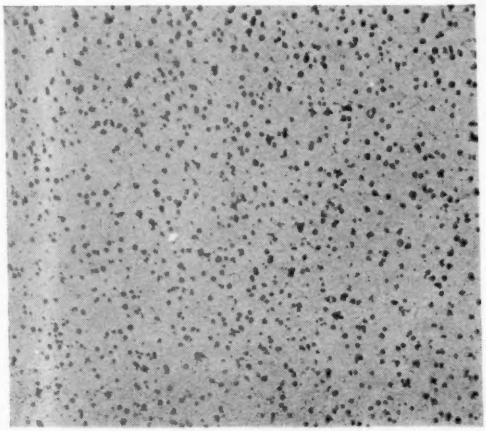

FIG. 21.—NODULAR STRUCTURE OF NICKEL-CARBON INGOT QUENCHED IN WATER JUST AFTER THE COMPLETION OF THE EUTECTIC ARREST. UNETCHED. × 60.

undercooling has occurred. A careful examination of many samples has also revealed that spherulitic nodules tend to be associated with inverse chill in specimens which also contain undercooled graphite. This is illustrated in Fig. 23, where the acicular structure of the carbide of the inverse chill is again apparent. In normal cases of inverse chill the carbide is stable right down to room temperature, but occasionally it decomposes after solidification, at a temperature lower than that required to give undercooled graphite, with the formation of spherulites.

Summary and Conclusions

A brief survey has been made of some of the more important problems relating to the formation of graphite in cast irons. Involved in many of these problems is the question of the mechanism by which

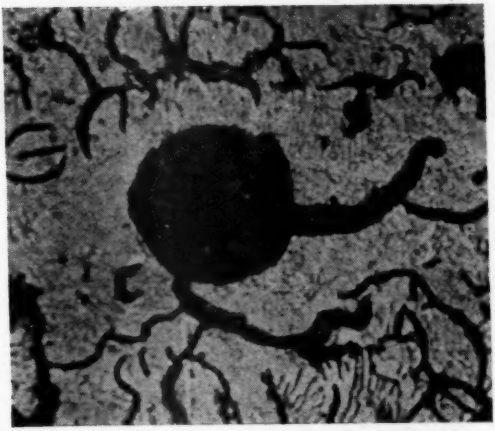

FIG. 22.—SPHERULITE OF HYPER-EUTECTIC GRAPHITE IN A HYPER-EUTECTIC CAST IRON. ETCHED IN PICRIC ACID. × 1,500.

undercooling occurs with the formation of fine graphite. The work of Eash showing that undercooling graphite results from the solidification of a white iron eutectic which subsequently decomposes after solidification has been confirmed. The form of this white iron differs from that of normal white iron in the acicular distribution of the carbide, which is similar to that occurring in inverse chill.

Experiments have been carried out on graphite formation and undercooling in the analogous systems nickel-carbon and cobalt-carbon, and it has been found that undercooling occurs in both, with the solidification of a carbide-containing eutectic which decomposes after solidification. The presence of certain elements, namely calcium, magnesium, strontium and barium, retard the decomposition of the carbide in the nickel-

carbon system, with the eventual formation of graphite spherulites.

It has also been found that spherulitic graphite nodules can be produced in cast irons without any heat-treatment under the conditions predicted as a result of the findings with respect to the nickel-carbon and cobalt-carbon systems. For a more comprehensive treatment of the whole problem, reference should be made to another Paper published by the present Authors[1] (*loc. cit.*).

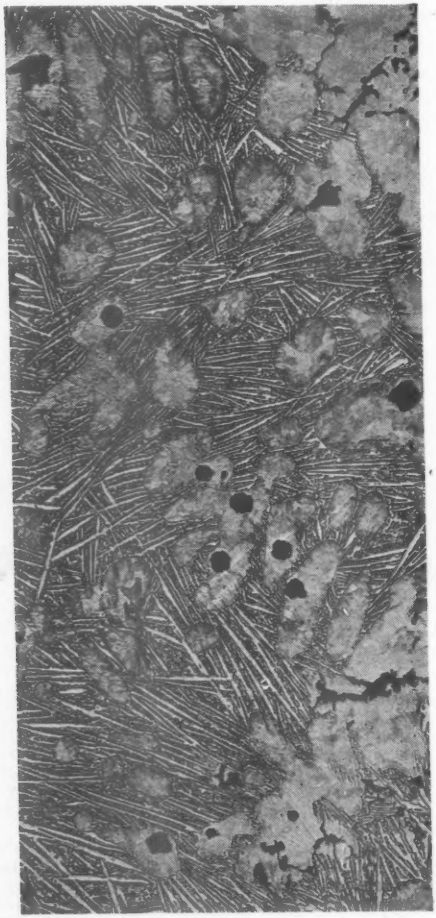

FIG. 23.—SPHERULITES OF GRAPHITE ASSOCIATED WITH INVERSE CHILL AT THE CENTRE OF THE SECTION OF A HYPO-EUTECTIC CAST IRON CONTAINING UNDERCOOLED GRAPHITE. ETCHED IN PICRIC ACID. × 60

The work reported here forms part of a long-term research upon graphite formation being carried out in the laboratories of the British Cast Iron Research Association. Using the guiding principles indicated by the present work, it has been possible to produce as-cast cast irons with the graphite entirely in the nodular form. A description of this work will be given in due course.

The Authors desire to thank the Council of the British Cast Iron Research Association for permission to publish the work recorded in this Paper, the Director, Mr. J. G. Pearce, for his interest and encouragement, and the Research Committee of the Association for their helpful criticism and forbearance while the work was being carried out. The Authors particularly wish to acknowledge their indebtedness to Dr. A. L. Norbury and Mr. E. Morgan, who pioneered the work on graphite formation at the laboratories of the Association, and who provided a basis of experience and experiment which has been fully drawn upon. Finally, they are indebted to their colleagues for assistance in many ways, and particularly to Mr. D. Marles, of the Association's Metallographical Laboratory.

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(*References concluded on Page 6*)

Imports and Exports of Iron and Steel

Board of Trade Returns for July

The following tables, based on Board of Trade returns, give figures of imports and exports of iron and steel in July and the first seven months of 1947. Figures for the corresponding period of 1938 are given for purposes of comparison.

Total Exports of Iron and Steel.

Destination.	July, 1947.	Seven months ended July.	Seven-twelfth of 1938.
	Tons.	Tons.	Tons.
Eire	7,481	38,308	32,503
Channel Islands	814	4,025	4,326
Malta and Gozo	184	2,027	1,344
Cyprus	234	1,737	966
Palestine	5,251	26,305	4,708
British West Africa	5,739	28,323	29,017
Union of South Africa	14,753	95,565	134,801
Northern Rhodesia	922	4,835	12,002
Southern Rhodesia	1,200	11,558	21,124
British East Africa	4,020	23,493	15,127
British India	7,859	59,122	92,562
Burma	2,240	26,549	10,799
British Malaya	3,452	23,218	38,841
Ceylon	1,421	7,527	15,185
Hong Kong	2,241	13,389	13,764
Australia	2,712	22,305	99,694
New Zealand	3,982	29,035	76,932
Canada	2,109	9,269	49,822
British West India Islands	4,320	21,144	25,813
Anglo-Egyptian Sudan	1,231	7,031	4,836
Other British countries	5,431	25,405	10,480
Soviet Union	14	1,615	2,537
Finland	4,495	27,686	10,271
Sweden	12,267	58,556	6,985
Norway	5,601	31,271	11,826
Iceland	433	4,245	384
Denmark	11,149	62,510	50,899
Poland	106	546	1,451
Netherlands	9,070	59,687	30,076
Belgium	1,253	13,196	11,856
Luxemburg	1	599	61
France	2,946	13,962	7,809
Switzerland	1,676	10,130	1,623
Portugal	1,514	10,038	4,499
Spain	516	3,258	4,529
Italy	524	4,854	2,998
Greece	2,445	12,024	1,022
Turkey	937	8,760	8,025
Dutch East Indies	2,962	14,503	15,929
Dutch West India Islands	1,525	6,891	1,437
Belgian Congo	242	1,170	177
Portuguese East Africa	156	2,874	8,295
Syria	329	2,242	1,520
Egypt	4,643	27,354	20,072
Iraq	8,821	41,565	15,015
Iran	8,416	34,569	64,388
China	10,080	32,957	13,131
U.S.A.	1,626	7,592	1,276
Colombia	629	5,406	2,230
Venezuela	3,863	19,083	2,727
Ecuador	630	3,492	929
Peru	379	2,667	1,769
Chile	1,487	6,346	3,671
Brazil	1,834	16,676	9,911
Uruguay	1,674	6,658	4,426
Argentine	10,143	49,286	46,291
Other foreign countries	3,920	32,803	52,914
Total	195,902	1,117,241	1,117,594

THE BOARD OF Geo. Adlam & Sons, Limited, manufacturers of chemical and brewing machinery, etc., of Bristol, proposes to change the capital structure of the company.

Total Imports of Iron and Steel.

From	July, 1947.	Seven months ended July.	Seven-twelfths of 1938.
	Tons.	Tons.	Tons.
British India	—	929	90,786
Australia	3,820	37,703	21
Canada	8,905	94,288	68,469
Other British countries	55	1,323	3,266
Sweden	1,204	6,675	52,381
Norway	2,522	15,954	19,702
Belgium	5,558	21,596	159,647
Luxemburg	1,529	4,236	34,184
France	85	1,052	150,119
U.S.A.	18,596	140,639	117,070
Other foreign countries	99	6,860	88,520
Total	42,373	331,255	784,157
Iron ore and concentrates—			
Manganiferous	640	44,259	36,332
Other sorts	745,581	3,772,352	2,976,091
Iron and steel, scrap and waste, fit only for the recovery of metal	78,567	236,924 •	368,785

Exports of Iron and Steel by Products.

Product.	July, 1947.	Seven months ended July.	Seven-twelfths of 1938.
	Tons.	Tons.	Tons.
Pig-iron	6,974	36,530	54,799
Ferro-alloys, etc.—			
Ferro-tungsten	74	498	301
Spiegeleisen and ferro-manganese	341	7,662	3,031
All other descriptions*	76	407	611
Ingots, blooms, billets and slabs	469	2,999	5,684
Iron bars and rods	1,205	3,803	1,865
Sheet and tinplate bars	—	46	7,222
Wire rods	558	1,661	1,855
Bright steel bars	2,554	16,273	3,843
Other steel bars and rods	14,261	88,069	59,503
Special steel	1,459	10,149	2,877
Angles, shapes and sections	9,016	61,127	39,010
Castings and forgings	569	3,505	944
Girders, beams, joists and pillars	2,196	18,906	19,525
Hoop and strip	4,740	24,086	21,803
Plates, ¼ in. thick and over	14,504	86,401	76,395
Black plates	5,662	19,812	8,481
Black sheets	6,245	28,702	37,048
Galvanised sheets	6,926	33,461	85,712
Tinplates	12,049	82,774	186,266
Tinned sheets	780	2,592	823
Terneplates	126	372	2,523
Decorated tinplates	196	655	2,548
Cast-iron pipes, up to 6-in. dia.	5,735	32,047	28,541
Do., over 6-in. dia.	4,515	23,134	25,062
Wrought-iron tubes	25,390	144,490	128,317
Radiators and central-heating boilers	567	2,425	2,350
Railway material	9,804	94,602	92,257
Wire	3,865	30,711	32,190
Cable and rope	2,559	16,183	9,567
Netting, fencing and mesh	1,567	9,677	5,493
Other wire manufactures	569	4,364	2,142
Nails, tacks, etc.	724	4,702	2,221
Rivets and washers	781	4,441	4,979
Wood screws	374	2,526	1,465
Bolts, nuts and metal screws	2,070	13,277	10,251
Stoves, grates, etc. (excl. gas)	554	3,621	4,086
Sanitary cisterns	94	476	1,640
Fencing material	786	4,560	2,993
Anchors, etc.	961	5,210	3,696
Chains	935	5,105	3,670
Springs	404	3,663	2,293
Hollow-ware	7,843	35,751	6,244
All other manufactures	34,825	145,786	125,479
Total	195,902	1,117,241	1,117,594

• The figures for 1938 are not completely comparable with those for subsequent years.

News in Brief

THE FURNESS SHIPBUILDING COMPANY, LIMITED, Haverton Hill-on-Tees, have launched the 8,200-ton Nigerian, built for the United African Company.

WOLFRAM MINING in Portugal, which ceased when the Government banned export of the metal in June, 1944, has this year been resumed; 625 tons were produced in the first quarter.

NINETY-THREE past and present employees of Bayliss, Jones & Bayliss, Limited, iron and steel rollers, etc., of Wolverhampton, have received recognition of their long service with the company.

AFTER A ONE-DAY unofficial strike, 1,000 men at the Workington plant of the United Steel Companies, Limited, resumed work pending negotiations for a settlement of a wages dispute.

THE EXEMPTIONS from purchase tax of certain road vehicles and fuel economy accessories for grates, ranges and fireplaces, which the Treasury announced on August 1, came into force on September 1.

BLAST-FURNACE GAS, which has hitherto been wasted, will be used to generate electrical power for Derbyshire and Nottinghamshire through developments at the Renishaw Iron Company, Limited, near Sheffield.

EIGHT OF THE 14 open-hearth furnaces in the Templeborough melting shop of Steel, Peech & Tozer Branch of the United Steel Companies, Limited, will be operating on oil by the end of this year. The amount of coal saved will be 150,000 tons annually.

THE EIGHTIETH BIRTHDAY of R. A. Lister & Company, Limited, agricultural engineers, ironfounders, etc., of Dursley, Glos, was celebrated on August 23. Included in an exhibition was a hand-operated lathe used by Mr. R. A. Lister (later Sir Ashton Lister) when he started the company.

ORDERS FOR eight cargo liners of 11,000 tons deadweight have been placed on the North-East Coast by Ellerman Lines, Limited. Swan, Hunter & Wigham Richardson, Limited, are to build four, Vickers-Armstrongs, Limited, two, and the Furness Shipbuilding Company, Limited, and Joseph L. Thompson & Sons, Limited, one each.

LEYLAND MOTORS, LIMITED, is to enter the markets of the marine and industrial oil engines. The new enterprise has been developed jointly for marine purposes by Thomson & Taylor (Brooklands), Cobham, Surrey, and Leyland Motors, Limited. Thomson & Taylor will market the engine in this country, while the export division of Leyland Motors will handle sales overseas.

THE BOARD OF Metal Closures, Limited, intend to increase the capital of the company from £100,000 to £150,000 by the creation of 250,000 4s. shares. It is not proposed to issue the new shares immediately, but to keep them in reserve, as the directors believe they should be in a position to take advantage of any opportunity that may occur profitably to expand the company's activities and strengthen its position.

Obituary

MR. JOHN A. HORNE, late assistant metallurgist, Newton Chambers & Company, Limited, Sheffield, died on August 16, aged 21.

MR. STEWART MCINTOSH, North-East Coast agent for Whessoe, Limited, engineers, etc., of Darlington, has died at Monkseaton, aged 67.

MR. GEORGE W. CLARKE, a specialist on gear and spline grinding with A. C. Wickman, Limited, Coventry, since 1938 and previously works superintendent with the Gear Grinding Company, Limited, Birmingham, died on August 16, aged 62.

MR. HUBERT A. ELWELL, for many years secretary of Henry Meadows, Limited, manufacturers of petrol and Diesel engines and gearboxes, of Wolverhampton, has died at the age of 55. He joined the company shortly after its formation 27 years ago.

MR. ANDREW JOLLIE, chairman of Steel, Peech & Tozer Branch of the United Steel Companies, Limited, and a director of the United Steel Companies, Limited, died recently after 50 years in the steel industry, 25 years of which he spent with Steel, Peech & Tozer. He retired last year from the chairmanship of the National Association for Rolled and Re-rolled Steel Products, of which he was one of the founders, and held office for many years as chairman of the Billet Associations.

MR. PHILIP RAVENSCROFT RICHARDS, who died on August 22 at the age of 54, had been associated with Charles Richards & Sons, Limited, nut and bolt manufacturers, etc., of Darlaston, Staffs, and had been a director of the company since the death of his father in 1929. Two years ago he became joint managing director with his cousin, Mr. Charles Richards, jun. He had been in ill-health for about a year, but had been able to attend to his business activities during that time.

COL. JAMES SAMUEL TRINHAM, a leading authority on the manufacture of wrought iron, died on August 25. He was 80. He was a director of N. Hingley & Sons, Limited, Netherton, Dudley, from which he retired quite recently. Col. Trinham was a member of the British Standards Institution, the Staffordshire Iron and Steel Institute, the American Society for Testing Materials, the Central Council of the Iron and Steel Employers' Association and the Birmingham Iron Exchange (of which he was formerly president and chairman). He was a member of the Iron and Steel Industry Research Council. Col. Trinham had been a member of the Midland Iron and Steel Wages Board since 1911, and was its chairman from 1933 to 1942. He was also a member of the British Iron and Steel Federation, and chairman of the Cinder Committee of the South Staffordshire Iron and Steel Association.

EXTENSIONS BEING made by Yorkshire Copper Works, Limited, manufacturers of tubes and fittings, of Leeds, are expected to result in the company's output being doubled.

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BY USING
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HOLWELL
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SAND-LESS
MACHINE CAST
PIG IRON
THE STANTON IRONWORKS COMPANY
LIMITED
NEAR NOTTINGHAM

Company News

(Figures for previous year in brackets.)

Bylock Electric—Interim dividend of 100% (nil).

Thorn Electrical Industries—Dividend of 25% (20%).

John Oakey & Sons—Interim dividend of 2½% (same).

John C. Parkes & Sons—Interim dividend of 3½% (same).

Linley Engineering Company—Dividend of 10% (same).

Aluminium Plant & Vessel Company—Interim dividend of 16⅔% (same).

Head, Wrightson & Company—Final dividend of 7% (6½%), making 10% (9%).

Lane Fox & Company—No dividend for the year ended December 31, 1946 (10%).

George Cohen Sons & Company—Final dividend of 8½%. The company was made public in March last.

Wales—Final dividend of 10%, making 15% (same), and interim dividend of 5% (same) on account of 1947.

R.F.D. Company—No interim dividend is recommended (4%) because of the uncertainty of the present situation.

A. & J. Main & Company—Profit, after tax, £27,628 (£36,814); to general reserve, £15,000 (£20,000); dividend of 12½% (10% and special bonus of 5½%, tax free); forward, £13,604.

Rippingilles—Net profit to March 31, after depreciation and directors' fees, £8,675 (£17,856); to tax, £3,785 (£8,821); war damage, nil (£7); reserve, £2,500 (same); dividend of 7½% (same); forward, £4,409 (£6,144).

Hartley & Sugden—Net profit for the year ended June 30, £5,756 (£7,521); to taxation, £2,000 (£3,600); general reserve, £1,500 (£2,000); deferred repairs, nil (£2,000); dividend of 6% (same); forward, £2,753 (£3,093).

Cowans, Sheldon & Company—Profit for the year ended June 30, after depreciation, administration expenses, and taxation, £35,920 (£37,002); dividend of 15% (same); to general reserve, £12,500 (£10,000); forward, £62,401 (£61,481).

S. P. Austin & Son—Net profit for the year ended April 30, after taxation, depreciation, etc., £12,039 (£11,580); to directors' fees, £1,363 (same); staff pensions reserve, £1,500 (same); general reserve, £3,500 (same); dividend of 10% (same); forward, £2,241 (£2,066).

Darlington Railway Plant & Foundry Company—Net profit for the year ended April 30 after depreciation, deferred repairs, E.P.T. and income tax, £8,388 (£6,106); to general reserve, £2,500 (£1,500); directors' fees, £850 (same); final dividend of 10% and bonus of 5%, making 20%; forward, £2,106 (£2,045).

Metal Closures—Profit for 1946, after depreciation, £59,536 (£58,642); to directors' fees, £350 (same); tax, £30,000 (£35,000); profit on sale of subsidiary, nil (£19,993); to general reserve, £6,993 (£10,000); final dividend of 25% (17½%), making 40% (30% and capital bonus of 10%, tax free); forward, £18,444 (£18,251).

Crittall-Hope Metal Windows (South Africa)—Net profit to February 28, after depreciation and directors' fees, £122,279 (£82,980); premium on preference shares, £175 (nil); to taxation, £32,333 (£38,012); non-resident shareholders' tax, £7,500 (nil); ordinary dividend, £50,000 (nil); general reserve, £25,000 (£65,000); forward, £8,294 (£9,106).

C.V.A. Jigs, Moulds & Tools—Net profit for 1946, after depreciation, etc., £42,048 (£35,767); brought in, £139,585, less £136,000 to reserve in anticipation of eventual capitalisation for the benefit of "A" ordinary shareholders; to tax, £22,288 (£25,459); war damage, nil (£289); capital reserve, £2,827 (nil); accrued preference dividend, £655 (nil); ordinary dividends, £6,600 (£3,500); forward, £13,263.

Steel Ceilings—Loss for 1946, £2,549. The report states that trading during the year was insignificant, as production ceased during removal and installation of plant, first from Twickenham to Old Ford Road and then to Port Talbot. Production commenced at Port Talbot in January and has since shown a steady increase. (Capital reorganisation scheme sanctioned in July, 1946.)

Geo. Adlam & Sons—Trading profit to March, 31, £31,561 (£22,175); to depreciation, £3,910 (£4,516); directors' fees, £1,050 (same); interest and charges, £591 (£2,287); war damage, nil (£109); income tax, £8,031 (£5,554); E.P.T. and profits tax, £5,985 (£3,439); dividend on the 8% cumulative preference shares for the three years to May 31, 1940, £13,200 (one year, £4,200); forward, £1,480 (£2,666).

Fishers Foils—Trading profit for the year ended April 30, £23,555 (£18,510); E.P.T. recoverable, nil (£11,539); investment interest, £1,815 (£1,764); profit on sale of investments, £326 (nil); to directors' fees, £950 (same); tax, £12,850 (£14,418); war risks contingencies, nil (£1,500); deferred repairs, nil (£4,000); rehabilitation reserve, nil (£8,000); special depreciation, £10,000 (nil); dividend of 5% (same); forward, £7,608 (£8,340).

MR. R. FRANK HOWARD, senior partner of Henry Butcher & Company, Limited, metal trades valuers, of 73, Chancery Lane, London, W.C.2, has returned from a business tour of the United States.

THE COMPANIES REGISTRATION OFFICE gives notice that the names of the undermentioned companies have been struck off the register, and are thereby dissolved:—Arcourt Engineering Company, Limited; British Sheet Metal Association, Limited; Duo-Cisterns, Limited; E. Ayers & Company, Limited; Elkaf Engineering Company, Limited; Fabricated Metal Industries, Limited; Grantwest Engineers, Limited; Hollis Metal Products, Limited; Leeds Combustion & Engineering Company, Limited; Yorkshire Engineering Company (Egypt), Limited.

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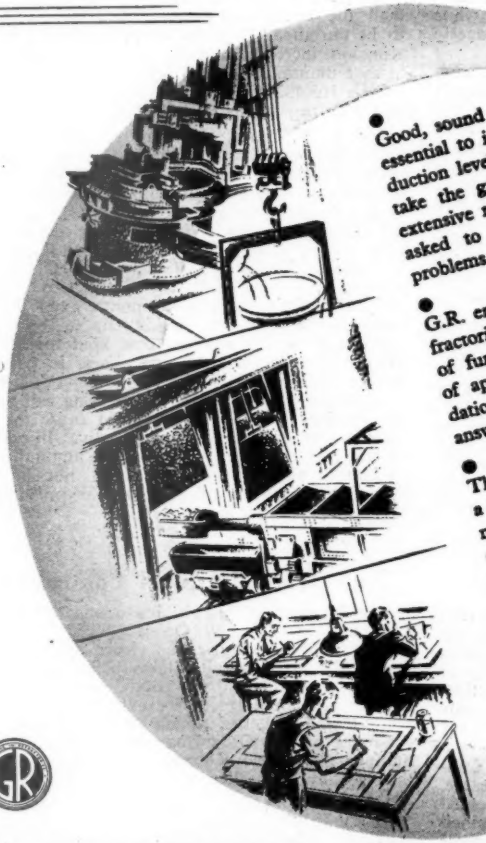

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192 ★ Visit stand No. 12—Row F—Grand Hall, at the "Foundry Trades' Exhibition," Olympia—August 28th, to September 13th.

Raw Material Markets

Iron and Steel

Banking on the promise of more coal, ironmasters are putting more blast-furnaces into operation, and the downward trend of pig-iron production has been reversed. In the second quarter of the current year a record output of iron castings was achieved and the Council of the Ironfoundry Associations is confident that further expansion is possible if more iron is provided. A big increase in basic-iron production is also called for to meet the needs of the steelworks, while all available tonnages of suitable scrap are eagerly absorbed.

The re-rolling industry is so heavily engaged on both light sections and bars for home delivery that export orders can only be accorded scant attention. No doubt bigger outputs could be achieved were steel semis more freely available. But supplies of billets and slabs are short, and even the sheet mills are finding it difficult to maintain full operations owing to the limited deliveries of sheet bars. Moreover, a shrinkage of imports is more probable than any expansion and it would appear that re-rollers will soon be almost wholly dependent on home sources of supply. In these circumstances full absorption of maximum tonnages of semi-processed steel, both primes and defectives, is assured.

The pressure of demand for plates, particularly the lighter gauges is intense and the assistance of some of the heavy sheet mills has been enlisted to swell the output of plates. Angles and large sections are also heavily specified and it is becoming increasingly difficult to cope with even the most pressing requirements. Sheet mills, too, have far more business offered than they can possibly cope with. Wire drawers are in much the same position, and collieries are not finding it easy to secure acceptance of their licensed tonnages of rails, props, arches and bars.

Non-ferrous Metals

Figures issued by the British Non-ferrous Metals Federation show that consumption of copper in the United Kingdom in July was 46,779 tons, against 49,131 tons in the previous month. U.K. imports of copper in July were less than the rate of consumption, due to the arrivals of non-electrolytic metal being only 8,863 tons. Electro copper imports totalled 17,361 tons.

When he spoke at the annual meeting of Consolidated Tin Smelters, Limited, Mr. Ernest V. Pearce, chairman and managing director, said that it seemed most inequitable that those producers who strained every nerve and in many cases seriously depleted their richer ore reserves in order to further the war effort should, more than two years after the cessation of hostilities, be subject to an arbitrarily controlled price for their product. If the world were willing to pay a higher price than that now ruling, the producer should have the benefit, for it was certain that as soon as supplies began to exceed demand, even by a comparatively small tonnage, a position which might well arise during the next two or three years, the price would fall. Mr. Pearce said that a world price for tin could be established only by creating a free market and allowing the forces of supply and demand to operate. Until the London Metal Exchange was reopened, producers the world over would remain dissatisfied and lacking in that incentive to production which a free market would provide.

Supplies of lead continue to be somewhat restricted, with the result that fabricators' activities are having to be curtailed. Imports of pig-lead into the United Kingdom increased in July, 29,835 tons being imported in that month. The total for the seven months of the year is 103,432 tons, which compares with 77,506 tons in the corresponding period of last year.

Mr. J. W. Wolff, chairman of the London Metal Exchange, has recently replied to a suggestion that the market was not now seeking permission to reopen. He said they would be only too glad to resume business at the earliest possible opportunuity. At the moment the market was not waiting on the doorstep of the Government with a daily request that it be permitted to reopen. There was little point at this juncture in pressing a further claim when the Government had refused a similar appeal a month ago. There were many people who were waking up to the fact that a terminable market was the best kind for metals, said Mr. Wolff. Copper and zinc prices, in particular, in Britain bore no relation to world prices. The sellers' market was showing signs of collapsing and the market was hoping that these facts would cause the Government to change its mind very shortly. In addition the market had always provided a large amount of foreign exchange, and though this could not be expected immediately on reopening, it would no doubt soon begin to earn other currencies.

New Iron and Steel Control Order

The Minister of Supply has made the Control of Iron and Steel (No. 59) Order, which came into force yesterday (Wednesday). The Order amends maximum prices, the principal alterations being increases in the price of rainwater and soil goods, roping wire and wire ropes. Maximum prices for extra light-weight quality screwed and socketted tubing are established.

Copies of the Order may be obtained from H.M. Stationery Office, Kingsway, London, W.C.2, or through any bookseller, price 2d. (S.R. & O., No. 1897. 1947).

MR. G. C. CASTLE, at one time well known in foundry circles, died on August 25 at Brixton.

MR. A. R. PARKES, who recently returned from India, has joined the staff of THE FOUNDRY TRADE JOURNAL.